SULPHATE OF POTASH FOR MULBERRY CULTIVATION

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Cover page Photo :
Paired Row Planting
of Mulberry raised by
using SOP

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FOREWORD

The silk industry in India has been playing an important role in enchancing the economic and social life of large number of people through ages. Sericulture in India is an important agro-based cottage industry providing employment to millions of people in the villages and earning foreign exchange to the tune of 600 crores per annum. Indian sericulture is mulberry-based; the climatic and edaphic conditions in the country are very conducive for the growth of mulberry in trun silk production.

Mulberry is a heavy feeder of nutrients attributing to its profuse vegetative leaf biomass production. The leaf quality is an important parameter in deciding the quality and sustainability of sericulture industry. The leaf quality is greatly influenced with different levels of inputs like irrigation, levels and sources of plant nutrients.

As an essential plant nutrient, potassium is known to have several functions inside the plant body and it has been associated with such roles as an enzyme activator, food former, root booster, stalk strengthner, breathing regulator, water stretcher, starch transporter, protein builder, wilt reducer, disease retarder, crop quality improver, chemical traffic policeman and so on.

The technical bulletin entitled **"Sulphate of Potash for Mulberry Cultivation"** comprises the outcome of the experiments on use of potassium sulphate in mulberry cultivation and impact on cocoon production, silk quality and grainage parameters considering all aspects systematically. This bulletin is based on the research efforts of Dr. M.A. Shankar, Dean (Agri), Agricultural College, Hassan, UAS, Bangalore. He has systematically documented the influence of different sources of potassium fertilizers on quality and sustainability of mulberry production. Hence, this publication will be of immense use to extension workers and farmers for improving the sustainability of sericulture industry in the country.

Bangalore
25.09.2009

(P.G. CHENGAPPA)

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The technical bulletin on **"Sulphate of Potash for Mulberry Cultivation"** comprises of results of the study on the influence of sources and levels of potassium, on the growth, development, yield and quality of mulbery in relation to silkworm, quality of seed cocoons, fecundity, filament length, rate of moth emergence and disease incidence, has been intensively studied over a span of five years.

The authors specially acknowledge the advice, guidance and support of Dr. P.G. Chengappa, Former Vice - Chancellor, UAS, Bangalore. Further, we would place on record our heartfelt thanks to Dr.T.K. Prabhakara Setty, Former Director of Research, UAS, Bangalore for his inspiration, support and encouragement.

We would like to place on records their profound gratitude to Dr. von Braunchweig, Head, Late Dr. Maibaum (Agronomist in-charge India) and Dr. Joseph Weibel (Agronomist), Kali und Salz, Germany, Area Manager and Officers of the Indian Potash Limited and Mr. Shenoi, Manager, Indian Potash Limited who have rendered invaluable guidance in shaping the present study and their critical suggestions during the project period are gratefully acknowledged.

It is a pleasure to thankfully acknowledge the authors of the scientific literatures and source of information, which we have referred in this bulletin and the farmers of Kolar and Bangalore Districts for their cooperation in conducting the field experiments.

Indeed we place on record our profound gratitude to Messrs. Kali und Salz, Germany and International Plant Nutrition Institute, Canada-India Programme for funding this project.

Last but not the least, we sincerely thank M/s Raman Printers, Bangalore for their timely and quality work carried out in bringing out this bulletin.

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Different studies were carried out on the use of potassium sulphate in mulberry cultivation and in turn its impact on nutrition quality of leaf and cocoon production at the University of Agricultural Sciences, Bangalore. In addition, experiments were laid out in farmer's field in different locations in and around Bangalore (Table 1) to study the efficacy of two main sources of potassium *i.e.,* potassium Chloride (MOP) and Potassium Sulphate (SOP) on growth, yield and quality of mulberry in relation to cocoon production and silk quality.

EXPERIMENT I

The efficacy of potassium sources on growth, yield and quality of mulberry in relation to cocoon production and silk quality under irrigated condition.

The treatments consisted of application of K as K_2SO_4 at 120, 160 and 180 kg/ha/yr in five splits in addition, two more treatments with K at120 kg/ha/yr each KCl and K_2SO_4 application in two splits were also evaluated.

Mulberry variety : M_5, spacing: 90 x 90 cm, Age of the garden: 3 years, Soil characters : Table 1

EXPERIMENT II

The efficacy of potassium sources on growth, development and yield of different mulberry varieties in relation to cocoon production and silk qulity under rainfed condition.

The treatment includes 4 varieties of mulberry (S_{34}. RFS_{175} MR_2 and M_5) and two sources of potassium (Potassium Sulphate and Potassium Chloride) at 50 kg/ha/yr planted at 90 x 90 cm spacing in two years old mulberry garden. Soil characters : (Table 1)

EXPERIMENT III

Effect of nitrogen and potassium levels on growth, yield and quality of mulberry in relation to young silkworm growth, cocoon production and silk quality.

The treatments were N:P:K @Tl;180:120:160 kg/ha/yr K as K_2SO_4, T2; 240:120:180 kg/ha/yr K as K_2SO_4, T3; 300:120:200 kg/ha/yr K as K_2SO_4 in five splits, T4; 300:120:120 kg/ha/yr K as K_2SO_4. (2 splits) and T; 5:300:120:120 kg/ha/yr K as KCl (2 splits).

Mulberry variety; S_{36}, spacing: 60 x 60 cm, Age of the garden: 3 years. Soil charecters : (Table 1)

EXPERIMENT IV

Effect of nitrogen and different levels of potassium sulphate on growth, yield and quality of mulberry in relation to seed cocoon production.

The treatments were N:P:K at T1; 200:120:160 kg/ha/yr K as K_2SO_4 (5 splits), T2; 250:120:180 kg/ha/yr K as K_2SO_4 (5 splits),T3; 300:120:120 kg/ha/yr K as Kcl (2 splits), T4; 300:120:120 kg/ha/yr K as K_2SO_4, T5; 350:120:160 kg/ha/yr K as K_2SO_4 (5 splits) and T6; 400:120:180 kg/ha/yr K as K_2SO_4 (5 splits)

Mulberry variety: M_5, spacing 60 x 60 cm, Age of the garden; 3 years, Soil characters : (Table 1)

EXPERIMENT V

Effect of nitrogen and varied potassium sulphate levels on growth, yield and quality of mulberry in relation to seed cocoon production at farmer's field.

The treatments were: N:P:K at T1; 300:120:120 kg/ha/yr K as KCl, T2; 350:120:160 kg/ha/yr K as K_2SO_4, T3; 400:120:180 kg/ha/yr K as K_2SO_4 and T4; 300:120:120 kg/ha/yr K as K_2SO_4.

Mulberry variety: M_5, spacing :90 x 90 cm, Age of the garden: 4 years, Soil characters : (Table 1)

EXPERIMENT VI

Effect of graded levels of potassium and magnesium saturation of soils in relation to growth, yield and quality of mulberry.

The nitrogen, potassium and magnesium saturation levels of the experiments were NPK and Mg at T_1; 300:120 kg/ha/yr + 0 per cent Mg, T_2; 300:120:120 kg/ha/yr + 10 per cent Mg, T_3; 300: 120:120 kg/ha/yr K_2SO_4 + 20 per cent Mg,T_4; 300:120:120 kg/ha/yr + 30 per cent Mg, T_5; 300:120:160 kg/ha/yr + 0 per cent Mg, T_6; 350:120:160 kg/ha/yr + 10 per cent Mg, T_7; 350:120:160kg/ha/yr + 20 per cent Mg, T_8; 350:120:160 kg/ha/yr + 30 per cent Mg,T_9; 400:120:200 kg/ha/yr + 0 per cent Mg,T_{10}; 400: 120:200 + 10 per cent Mg, T_{11}; 400:120:200 kg/ha/yr + 20 per cent Mg, and T_{12}; 400:120:200 kg/ha/yr + 30 per cent Mg, Mulberry variety: M_5, Pot culture study (One year)

Table 1 : Physico-chemical properties of the soil at the experiment sites

Particulars	M.R.S Hebbal	Anekal seed	Kunigal area		Sathanur	Sreenivasa-pura	Venkatagiri-kote	Method followed
1) Course sand (%)	38.50	34.00	43.00		41.65	41.00	42.31	International pipette method
2) Fine sand (%)	41.70	32.00	12.92		30.75	34.51	36.51	
3) Silt (%)	14.0	10.06	29.52		10.50	18.48	10.32	
4) Clay (%)	8.0	25.62	19.20		17.10	7.38	10.36	
Chemical properties prior to commencement of experiments								
1) Soil pH	7.2	7.5	6.9		6.9	6.5	**7.1**	Piper, 1996
2) EC dms/cm^2 (Electrical conductivity)	0.21	0.11	0.17	0.09	0.09	0.05	0.07	Piper, 1966
3) Organic matter (%)	0.40	0.66	0.55	1.02	1.02	0.54	0.56	Walkie & Black
4) Available N (kg/ha)	357	492	462	462	300	275	295	Subbraih & Asija 56
5) Availae P_2O_5 (kg/ha/)	42	35	32	32	45	45	35	Bray's method
6) Available K_2O (kg/ha)	122	114	92	92	126	112	210	Jackson, 1973
Chemical properties after completion of the experiments								
1) Soil pH	7.00	7.3	6.9					
2) EC dms/cm^2 (Elecrical conductivity)	0.24	0.21	0.2					
3) Organic matter (%)	0.41	0.60	0.53					
4) Available N (kg/ha)	300	439	427					
5) Availae P_2O_5 (kg/ha/)	39	33	35					
6) Available K_2O (kg/ha)	119	110	90					

The experiments were conducted on the use of potassium sulphate in combination with different nutrients on growth, development, yield and quality of mulberry in relation to silkworm growth, cocoon production and silk quality are presented in the succeeding chapters.

MULBERRY LEAF YIELD

The mulberry leaf yield showed significant difference due to application of two different sources of potassuim at different levels along with nitrogen.

Fresh Leaf Yield per plant

Application of potassium at 180 kg/ha yr in the form of potassium sulphate gave significantly higher fresh mulberry leaf yield per plant in all the locations tried (Main Research Station 501 g, Sathanur 620 g, Venkatagiri Kote 624 g, Sreenivasa Pura 563 g per plant) (Table 2) when compared to normal farmers practice wherein the potassium chloride was used as K source at 120 kg/ha/yr (in 2 splits) (448, 509, 547 and 435 g per plant respectively in the above mentioned locations). (Shankar, 1997)

Table 2 : Leaf yield parameters of mulberry as influenced by different sources of potassium in different locations under farmer's field condition.

Treatement (kg/ha/yr)	Leaf yield per plant (g)				Total leaf yield (t/hayr)			
	MRS. Hebbal	Sathanur	Ventakata girikote	Sreenivasa-pura	MRS. Hebbal	Sathanur	Ventakata-giri Kote	Sreenivasa-pura
T1 120 kgK K_2SO_4	436	546	546	533	31.1	37.8	36.3	33.0
T2 160 kgK K_2SO_4	448	580	572	567	32.1	39.5	40.2	34.6
T3 180 kgK K_2SO_4	501	620	624	563	36.1	40.1	41.1	35.6
T4 120 kgK Kcl	464	508	544	478	33.3	40.6	34.9	29.9
T5 160 kgK Kcl	480	565	570	487	34.5	38.3	40.1	30.0
T6 180 kgK Kcl	478	583	616	543	34.4	37.6	40.4	33.5
T7*120 kgK K_2SO_4	432	524	567	472	30.8	37.4	33.6	29.2
T8 * 120 kgK KCl	448	509	547	435	32.1	34.2	33.3	26.9
f test	*	*	*	*	*	*	*	*
C.D. at 5%	35.62	37.75	33.10	25.99	0.93	2.10	2.11	1.02

* 2 splits

Rajegowda and Shankar (2000) observed that fresh leaf yield per plant of mulberry was higher to the extent of noteworthy when nitrogen and potassium in the form of SOP was applied at 300:200 kg/ha/yr recorded higher leaf yield per plant in both the years of experimentation at Main Research Station, Hebbal, Bangalore (141 g in the first year and 487g in the second year) (Table 3). In addition, in another experiment with other combinations of nitrogen and potassium also confirmed the fact that the application of higher quantity *i.e.*, 400 kg/ha/yr nitrogen with 180 kg/ha/yr potassium as SOP resulted in higher leaf yield per plant (223 and 512 g/plant in the first and second year respectively) when compared to normal practice of application of nitrogen and potassium (MOP) (Table 4)

Table 3 : Average fresh leaf yield per plant and total leaf yield per hectare of mulberry as influenced by N & K_2SO_4 levels at Main Research Station, Hebbal.

Treatments kg/ha/yr	Fresh leaf yield/plant (g)		Total leaf yield (t/ha/yr)	
	1st year	2nd year	1st year	2nd year
T1 180:120:160 K_2SO_4	127	409	18.7	27.2
T2 240:120:180 K_2SO_4	140	423	21.0	30.3
T3 300:120:200 K_2SO_4	174	511	25.6	34.2
T4 300:120:120 K_2SO_4	141	487	21.5	32.9
T5 300: 120: 120 KCl	171	482	23.6	31.6
F test	*	*	*	*
CD at 5%	29.9	22.1	3.80	0.89

The studies carried out in different locations at Anekal and Kunigal seed area under farmers field condition on use of SOP. Magnesium along with nitrogen revealed that application of higher nitrogen at 400 kg/ha/yr with 180 kg/ha/yr potassium as SOP gave higher leaf yield per plant (614 g in Kunigal and 237 g in Anekal) when compared to normal practice N & K (as MOP) applicaiton at 300:120 kg/ha/yr (598 g in Kunigal195 g in Anekal) (Table 5)

A pot culture experiment with different combinations of nitrogen and potassium along with different levels of magnesium saturation noticed higher leaf yield per plant when nitrogen and potassium (SOP) was applied at 400:180 kg/ha/yr with 20 per cent magnesium (75.88 g plant) when compared to other combinations (Table 6). (Rajegowda and Shankar, 2000*)*

Table 4 : Yield parameters of mulberry as influeuced by N & K_2SO_4 levels at M.R.S. Hebbal

Treatment kg/ha/yr	K source	Leaf yield/plant (g) I year	Leaf yield/plant (g) II year	Total leaf yield/t/ha/year I year	Total leaf yield/t/ha/year II year
200:120:160	K_2SO_4	151	311	20.9	23.1
200:120:180	K_2SO_4	163	384	21.5	24.6
300:120:120	Kcl	180	478	25.1	29.3
300:120:120	K_2SO_4	196	499	26.8	30.4
350:120:160	K_2SO_4	212	503	27.8	31.75
400:120:180	K_2SO_4	223	512	30.6	32.3
F test		*	*	*	*
C.D.at 5%		2.5	29.6	2.7	2.20

The study initiated in dryland condition to study the response of different mulberry varities to the sources of potassium revealed that the variety RFS;175 with SOP as K source (344g per plant) performed better than other varities when compared to use of MOP as K source. All the varities respond better to SOP when used as K source instead of MOP (Table 7)

Use of SOP as K source in splits along with higher levels of nitrogen is highly beneficial for obtaining higher mulberry leaf yield per plant.

TOTAL LEAF YIELD

Shankar (1997) observed that application of potassium in the form of SOP at180 kg/ha/yr gave higher total leaf yield per hectare per year in all the locations, wherein the experiments were conducted in farmers field and at Main Research Station, Hebbal, on use of SOP in graded levels. The leaf yield obtained was 36.1 t/ha/yr in MRS, 40.2 t/ha/yr in Sathanur, 41.0 t/ha/yr in Venkatagirikote and 35.6 t/ha/yr in Sreenivasapura (Table 2)

The total leaf yield per hectare per year was significantly higher (8%) when nitrogen and potassium (SOP) was applied in 5 splits at 300:200 kg/ha/yr (25.6 and 34.2 t/ha/yr in the I and the II year respectively), when compared to control *i.e.* nitrogen and potassium (MOP) applied at 300:120 kg/ha/yr (23.6 and 31.6 t/ha/yr) (Table 3). Further, in another two year study conducted on use of graded levels of nitrogen and potassium, once again application of higher dose of nitrogen along with higher rate of potassium (SOP) at 400:180 kg/ha/yr gave higher (21.7 and 31.44 % in I and II years) leaf yield. When compared to existing package of practice *i.e.* nitrogen and potassium (MOP) application at 300:120 kg/ha/yr (25.1 t/ha/yr in I year and 33.5 t/ha/yr in the II year) (Table 4) (Rajegowda and Shankar, 2000)

Table 5 : Fresh leaf yields per plant and total leaf yield per hectare of M5 mulberry as influenced by N and K_2SO_4 levels at farmer's field

Treatment kg/ha/yr	Fresh leaf yield (g)		Leaf yield (t/ha/yr)	
	Kunigal seed area	Anekal seed area	Kunigal seed area	Anekal seed area
T1 300:120:120 Kcl	500	195	16.8	16.2
T2 350:120:160 K_2SO_4	567	225	19.0	18.8
T3 400:120:180 K_2SO_4	614	237	20.4	19.7
T4 300:120:120 K_2SO_4	543	201	18.3	16.8
F test	*	*	*	*
C.D.at 5%	37.6	7.7	1.1	0.60

Multilocation farmer's field trials revealed that application of nitrogen ana potassium (as SOP) at higher rate *i.e.*, 400: 180 kg/ha/yr gave higher yield 21 per cent higher leaf biomass (20.4 t/ha/yr in Kunigal seed area and 19.7 t/ha/yr in Anekal seed area) when compared to growing of mulberry with normal practice *i.e.*, application of nitrogen and potassium (as MOP) at 300:120 kg/ha/yr (16.8 and 16.2 t/ha/yr in the above locations) (Table 5)

Table 6 : Fresh leaf yield per plant of M_5 mulberry as influenced by N and K_2SO_4 levels in combination with different levels of Mg saturation

Treatments	Mg%	Fresh leaf yield/plant
T1 300:120:120	0	60.70
T2 300:120:120	10	65.99
T3 300:120:120	20	68.30
T4 300:120:120	30	70.40
T5 350:120:160	0	65.97
T6 350:120:160	10	69.96
T7 350:120:160	20	73.35
T8 350:120:160	30	71.70
T9 400:120:180	0	68.26
T10 400:120:180	10	71.66
T11 400:120:180	20	78.88
T12 400:120:180	30	71.58
F test		*
C.D.at 5%		10.84

(Nagaraju and Shankar, M.A., 1997)

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Table 7 : Mulberry leaf yield of different varieties as influenced by sources of potassium

Treatment		
Leaf yield/plant	Leaf yield kg/ha/yr	
(g)	(g)	(t/ha/yr)
V_1K_1	209	9.9
V_1K_2	237	11.8
V_2K_1	277	13.7
V_2K_2	295	14.0
V_3K_1	317	15.7
V_3K_2	344	17.7
V_4K_1	154	7.6
V_4K_2	172	8.5
F test	*	*
C.D.at 5%	0.98	5.42

V_1:MR_2 V_2:S_{34}, V_3:RFS_{175}, V_4:M_5

K_1:KCl, K_2:K_2SO_4

(Nagaraju and Shankar, M.A., 1997)

An experiment with different varieties of mulberry with two sources of potassium under dryland condition recorded higher leaf yield in the RFS 175 variety with potassium sulphate as K source (17.7 t/ha/yr) which was 132 per cent higher over ruling mulberry variety M_5 with normal practice where in MOP as K source was used (Table 7) (Nagaraju and Shankar, 1997)

The significant increase in leaf yield in the treatments when higher rates of nitrogen along with potassium was applied may be due to application of sulphate of potash which contributes potassium and sulphur in additon to application of nitrogen which have a role in carbohydrate synthesis and as a co-factor and constitute enzymes. Further, to increase the foliage yield balanced application of nutrients is very much essential which was done in these studies. Further, high rates of N can be utilised by the plants and transformed into high yields is possible only in the presense of higher K levels (Macleod, 1969; Bhavanandan and Mahipura, 1969) and sulphur involved in nitrogen metabolism improves the efficiency of nitrogen fertilizer (Anon, 1999).

Application of potassium in the form of sulphate of potash along with increased levels of nitrogen is highly beneficial for increasing (8 to 32 %) Mulberry leaf yield.

QUALITY PARAMETERS

All the macro and micronutrient content of the mulberry leaf was influenced to the extent of noteworthy due to the application of major sources of potassium at different levels along with other nutrients.

MACRONUTRIENTS

Nitrogen, phosphorous and potassium

Rajegowda and Shankar (2000) reported that different levels of potassium along with nitrogen had significant influence on major nutrient status of mulberry leaf. Nitrogen content of leaf was significantly higher when potassium as (MOP) was applied at 300: 120 kg/ha/yr (3.53%). The phosphorous (0.347%) and Potassium (2.16%) status in leaf was higher when 300:200 kg/ha/yr of nitrogen and potassium (as SOP) was applied to mulberry when compared to lower levels of nitrogen and potassium application (Table 8)

Further, in another experiment, a higher leaf nitrogen (2.99%), phosphorous (0.56%) and potassium (2.18%) was recorded when mulberry was supplimented with 400:180 K kg/ha/yr of nitrogen and potassium as (SOP) when compared to other lower levels of nitrogen and potassium sulphate application including control (Table 9).

Table 8 : Leaf quality parameters of mulberry as influenced by N and K_2SO_4 levels at Main Research Station. Hebbal.

Treatment kg/ha/yr	Moisture content (%)	Total chlorophyll content (mg/g)	N	P	K	Ca	Mg	S	TSS	Total soluble proteins (%)
			←			Per cent			→	
T1 180:120:160 K_2SO_4	73	1.83	2.75	0.26	1.96	2.19	0.41	0.32	11.47	12.72
T2 240:120:180 K_2SO_4	72	1.85	2.84	0.28	2.00	2.41	0.43	0.34	12.42	13.54
T3 300:120:200 K_2SO_4	73	1.93	2.81	0.35	2.16	2.61	0.49	0.35	13.02	16.21
T4 300:120:120 K_2SO_4	72	2.31	3.34	0.34	2.05	2.84	0.56	0.36	13.19	14.26
T5 300:120:160 KCl	72	2.10	3.53	0.33	2.06	2.58	0.49	0.34	12.69	14.81
F test	N S	*	*	*	*	*	*	*	*	*
C.D.at 5%		0.15	0.18	0.01	0.07	0.02	0.01	0.01	0.34	0.36

Table 9 : Leaf quality parameters of mulberry as influenced by N and K_2SO_4 levels.

Treatment kg/ha/yr	Moisture content (%)	Total chlorophyll content (mg/g)	N	P	K	Ca	Mg	S	TSS	Total soluble proteins (%)
			←			Per cent			→	
T1 200:120:160 K_2SO_4	70	1.92	2.24	0.44	1.69	1.76	0.51	0.25	12.49	13.61
T2 250:120:180 K_2SO_4	71	2.02	2.64	0.50	1.86	1.77	1.51	0.26	12.42	13.46
T3 300:120:120 KCl	72	2.13	2.82	0.53	1.97	2.09	0.52	0.26	13.10	14.51
T4 300:120:120 K_2SO_4	71	2.31	2.99	0.55	2.11	1.99	0.49	0.24	13.06	14.44
T5 350:120:160 K_2SO_4	72	2.29	2.97	0.56	2.13	1.99	0.40	0.30	13.05	15.54
T6 400:120:180 K_2SO_4	72	2.37	2.99	0.56	2.19	2.02	0.39	0.31	13.27	16.08
F test	N S	*	*	*	*	*	*	*	*	*
C.D.at 5%		0.16	0.13	0.03	0.08	0.01	0.01	0.01	0.60	0.35

A study on magnesium saturation in combination with nitrogen and SOP revealed that supply of higher rates of nitrogen (400 kg/ ha/yr) and potassium (180 kg/ha/yr) as SOP along with 30 per cent Magnesium recorded higher nitrogen (2.73%) phosphorous (0.45%) and potassium (2.93%) content in leaf (Table 10)

The results clearly indicate the fact that, application of SOP with nitrogen helps in increasing the major nutrient status in leaf. These results are in confirmity with the findings of Pain (1965), Ray *et al.* (1973). The treatments receiving higher this can be explained by the fact that K has synergestic interaction with N. Application of K_2SO_4 along higher N and P may lead to uptake of their nutrients more efficiently. In line with the present finding, Mangel *et al.* (1976) observed higer combination of N and K in the solution favoured the translocation N from roots resulting in higher N content in leaf. Further, higher K content in leaf may be due to increased quantity of potassium application to soil and its uptake by mulberry. Similar observations were made by Akune and Koga (1959), Aoki and Yamomoto (1968) and Ikuo and Takagishi (1985).

Table 10 : Nutritional status of M_5 mulberry leaf as influenced by N and K_2SO_4 levels in combination with different levels of Mg saturation

Treatment kg/ha/yr		Mg(%)	Mos-ture(%)	N	P	K	Ca	Mg	S	Fe	Zinc	Mn
				Per cent							(ppm)	
T1	300:120:120	0	68	2.46	0.44	2.67	2.54	0.42	0.21	569	59	144
T2	300:120:120	10	70	2.54	0.44	2.67	2.50	0.44	0.23	547	54	147
T3	300:120:120	20	72	2.55	0.44	2.71	2.60	0.49	0.20	565	55	148
T4	300:120:120	30	72	2.60	0.46	2.71	2.60	0.56	0.23	546	55	155
T5	350:120:160	0	70	2.69	0.47	2.72	2.56	0.46	0.25	564	60	155
T6	350:120:160	10	72	2.72	0.44	2.72	2.70	0.48	0.24	550	60	158
T7	350:120:160	20	72	2.72	0.44	2.71	2.60	0.50	0.24	561	58	156
T8	350:120:160	30	71	2.75	0.43	2.71	2.65	0.49	0.26	584	61	156
T9	400:120:180	0	70	2.79	0.44	2.72	2.55	0.37	0.25	566	58	147
T10	400:120:180	10	71	2.88	0.44	2.72	2.50	0.47	0.24	557	44	144
T11	400:120:180	20	72	2.92	0.44	2.72	2.60	0.48	0.25	574	52	154
T12	400:120:180	30	72	2.93	0.45	2.73	2.67	0.47	0.27	591	58	156
F test			*	*	*	*0.0178	NS	*	*	N S	NS	NS
C.D. at 5%			0.49	0.08	0.03		-	0.0971	3.1071	-	-	-

SECONDARY NUTRIENTS : CALCIUM, MAGNESIUM AND SULPHUR

The calcium (2.84%) and magnesium status (0.56%) of mulberry leaf was significantly higher when mulberry was supplimented-with 300 kg/ha/yr N along with 120 kg/ha/yr K (as SOP) was applied, when compared higher levels of potassium applications. Further, the sulphur (0.38%) content of leaf was higher 300:200 kg/ha/yr N and K (as SOP) was applied (Table 8). In another experiment, same trend was noticed when 300:120 kg/ha/yr nitrogen and potassium was applied to mulberry showed significantly higher calcium (2.09%) and magnesium (0.52%) content in leaf. However, the sulphur content was higher in the treatment when 400:180 kg/ha/yr nitrogen and potassium (as SOP) was applied to mulberry (Table 9). (Rajegowda and Shankar, 2000)

The data recorded on calcium and magnesium content in leaf showed an inverse relationship with the higher levels of potassium application which shows antagonistic effect of potassium on calcium and magnesium (Embleton, 1966). In line with this results Ikuo and Takagishi (1985) reported decreased calcium and magnsium content in the leaf with higher levels of potassium application (Rangaswamy, 1997)

Sulphur content in leaf increases (5%) with external supply of higher quantity of sulphur through sulphate of potash (Table 8, 9) which indicates that sulphur application helps in improving leaf sulphur status which is the constituent of essential amino acids *viz.* Cystene and methionine which are also the constituents of silk protien. This sulphur improvement helps in better silkworm growth, cocoon production and grainage parameters.

MICRONUTRIENTS

The micronutrient content of mulberry leaf was not much altered due to use of sulphate of potash at higher rates along with higher levels of nitrogen (Table 11). In turn, sulphate of potash application at 180 kg/ha/yr with 400 kg/ha/yr N along with 30 per cent magnesium saturation helped in increasing the iron content in leaf (Table 11) (Rajegowda and Shankar, 2000) which is a worth and most cautioned one while using the higher rates of nutrients.

The results clearly show that to increase the mulberry leaf yield, balanced proportion of major nutrients may be used without affecting the micronutrient status of leaf.

Table 11 : Nutritional status of mulberry leaf as influenced by N and K_2SO_4 levels in combination with different levels of Mg saturation

Treatment kg/ha/yr		Mg(%)	N	P	K	Ca	Mg	S	Fe	Zn	Mn
			← Per cent					→	← (ppm)		→
T1	300:120:120	0	2.46	0.44	2.67	2.54	0.42	0.21	569	59	144
T2	300:120:120	10	2.54	0.44	2.67	2.50	0.44	0.23	547	54	147
T3	300:120:120	20	2.55	0.44	2.71	2.60	0.49	0.20	565	55	148
T4	300:120:120	30	2.60	0.46	2.71	2.60	0.56	0.23	546	55	155
T5	350:120:160	0	2.69	0.47	2.72	2.56	0.46	0.25	564	60	155
T6	350:120:160	10	2.72	0.44	2.72	2.76	0.48	0.14	550	60	158
T7	350:120:160	20	2.75	0.43	2.71	2.65	0.49	0.26	561	58	156
T8	350:120:160	30	2.79	0.44	2.72	2.55	0.37	0.25	566	61	156
T9	400:120:180	0	2.88	0.44	2.72	2.50	0.47	0.24	557	54	147
T10	400:120:180	10	2.92	0.44	2.72	2.50	0.47	0.24	566	54	144
T11	400:120:180	20	2.92	0.44	2.72	2.60	0.48	0.25	574	52	154
T12	400:120:180	30	2.93	0.54	2.73	2.67	0.47	0.27	591	58	156
F test			*	*	*	N S	*	*	N S	N S	N S
C.D. at 5%			0.08	0.01	0.05		0.03	0.09			

MOISTURE CONTENT

Moisture content of leaf did not differ to the extent of noteworthy due to application of two different sources of potassium to mulberry with other nutrients (Rajegowda and Shankar, 2000).

CHLOROPHYLL CONTENT

The total chlorophyll content differed significantly with the different levels of nitrogen and potassium application to mulberry. It was significantly higher when N and K (as SOP) was applied at 300:120 kg/ha/yr (2.31 mg/g fresh weight) compared to control (2.10 mg/g fresh weight) (Table 8). Further, in another study significantly higher chlorophyll content was noticed once again in the same level of nitrogen and potassium (as SOP) at 400:120 kg/ha/yr application (2.37 mg/g fresh weight) when compared to other higher or lower levels of nitrogen and potassium application (Table 9)

The results indicates that application of N and K_2SO_4 at higher rates enhanced the total chlorophyll content of leaf which may be due to more availability of sulphur which is required for chlorophyll formation (Anon., 1999) and also increase in ribulose biophosphate carboaxylase enzyme activity which is responsible for photosynthetic Co_2 fixation (Yamashita and Hisaka, 1998). This increase in chlorophyll will in turn have been equivalent in providing greater nutrients of higher quality fresh leaf to silkworms.

TOTAL SOLUBLE SUGAR

The total soluble sugar content in the mulberry leaf was significantly higher when mulberry was grown by application of nitrogen and potassium (as SOP) at 400:180 kg/ha/yr (13.27%) when compared to lower levels of N and K application including control (13.10%) (Table 9). In another study, total soluble sugar content was significantly higher when 300:200 kg/ha/yr (13.02%) and 300: 120 kg/ha/yr (13.19%) of nitrogen and potassium (as SOP) was applied to mulberry,. in control when mulberry was grown by applicatin of N and K (as SOP) at 300:120 kg/ha/yr (12.69%) (Table 8).

The higher total soluble sugar content in leaf may be due to the fact that higher chlorophyll content in leaf and increased supply of potassium which leads to higher synthesis of sugars (Yamashita and Hisaka, 1998).

TOTAL SOLUBLE PROTIENS

The marked difference in soluble protien content in mulberry leaf was noticed due to application of nitrogen and potassium (as SOP) at higher levels. It was higher when N and K (as SOP) was applied at 350:160 kg/ha/yr (15.54%) and 400:180 kg/ha/yr (16.08%) when compared to raising of Mulberry on normal package *i e.* 300:120 kg/ha/yr N and K (as MOP) application (14.51%) in the above two studies respectively (Table 9) (Rajegowda and Shankar, 2000).

The increase in soluble protein may be due improvement in leaf nitrogen content due additional supply of sulphur through sulphate of potash which is the constituent of essential amino acids which is required for protein synthesis.

The results thus indicate an improvement in the quality of mulberry leaves in terms of improved nutrient status and leaf quality due to use of higher dose of potassium sulphate which is highly beneficial to sericulture industry in order to harvest cocoons with higher yield through better growth of silk worms and cocoons.

II INFLUENCE OF POTASSIUM SULPHATE ON SILK-WORM GROWTH, COCOON PRODUCTION AND POST COCOON PARAMETERS

SILKWORM GROWTH AND DEVELOPMENT

The silkworm growth was significantly influenced by feeding on leaf raised by application of two different sources of potassium along with different doses of nitrogen to mulberry.

MATURE LARVAL WEIGHT

The mature larval weight was significantly higher when worms were fed on mulberry leaf grown by application of 180 kg/ha/yr in the form of sulphate of potash in five splits (3.49g) when compared to application of potassium at lower levels including feeding of silkworms on leaf grown by application recommended package of practice *i.e.* 120 kg of potash (as MOP) (3.09g) (Table 12) (Shankar,1997).

Studies carried out on feeding of different breeds of silkworm to evaluate the efficacy of potassium sources on growth of silkworm reveals that rearing of worms on mulberry leaf raised by application of nitrogen and potassium (as SOP) at 300:200 kg/ha/yr recorded significantly higher mature worm weight (17.80, 40.37 and 35.34g in PM, NB_4D_2 and PMxNB_4D_2 breeds respectively) when compared to rearing of silkworms on leaf grown by following normal package of practice *i.e.* 300:120 kg nitrogen and potassium (as MOP) application (16.26, 38.15 and 33.64g in PM NB_4D_2 and PM NB_4D_2 breeds respectively (Table 13). In addition, another study on pure races (PM and NB_4D_2) confirmed the fact that feeding of silkworms with leaf grown by higher dose of nitrogen and higher rates of potasium in the form of sulphate of potash at 400:180 kg/ha/yr showed higher mature worm weight (17.1 and 38.21g in PM and NB_4D_2 breeds) when compared to feeding on leaf grown in control plot (15.6g in PM and 30.3 g in NB_4D_2) (Table 14) (Rajegowda and Shankar, 2000).

Table 12 : Silkworm growth, cocoon and postcocoon parameters as influenced by feeding of mulberry leaf obtained by application of different sources of potassium at different levels.

Treatment kg/hr/yr	Mature worm weight(g)	Single cocoon weight(g)	Shell weight (g)	Filament length(m)	Non breakable filament length(m)
T1 120kg K K_2SO_4	3.15	1.72	0.268	780	496
T1 160kg K K_2SO_4	3.42	1.73	0.288	817	509
T1 180kg K K_2SO_4	3.49	1.76	0.300	831	553
T1 120kg K KCl	3.01	1.65	0.266	771	490
T5 160kg K KCl	3.05	1.58	0.253	772	499
T6 180kg K KCl	3.27	1.63	0.281	784	511
T7 120kg K K_2SO_4	3.13	1.63	0.252	778	486
T8 120kg K K_2SO_4	3.09	1.65	0.230	777	492
F test	*	NS	*	*	*
C.D. at 5%	0.14	-	0.04	36.80	27.51

* Two splits

Table 13 : Silkworm growth and cocoon parameters as influenced by feeding of mulberry leaves obtained by application of different levels of N and K_2SO_4

Treatment kg/hg/yr	Matre worm wt. (g)			cocoon weight (g)			Shell weight(g)			No. of cocoons/kg		Filament length (m)		
	PM	BV	CB	PM	BV	CB	PM	BV	CB	PM	BV	PM	BV	CB
T1 180:120:160 K_2SO_4	13.46	24.0	22.8	0.82	1.53	1.28	0.10	0.28	0.19	1218	911	298	830	642
T2 240:120:180 K_2SO_4	13.79	26.7	23.6	0.82	1.62	1.30	0.10	0.29	0.20	1217	858	300	867	698
T3 300:120:120 K_2SO_4	16.03	34.9	34.3	0.90	1.72	1.34	0.11	0.33	0.21	1103	803	341	963	750
T4 180:120:200 K_2SO_4	17.00	40.4	35.3	1.07	2.01	1.51	0.14	0.38	0.24	937	625	359	968	780
T5 300:120:120 KCl	16.26	38.2	33.6	0.94	1.71	1.28	0.13	0.30	0.20	1061	798	350	927	751
F test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
C.D at 5%	0.70	0.86	0.64	0.07	0.09	0.01	0.01	0.01	0.01	40.49	30.20	22.1	49.5	1.8

The mature worm weight was significantly influenced by mulberry variety and potassium sources. RFS-175 variety grown by application of sulphate of potash as potassium source noticed higher mature worm in weight (33.33 g in cross breed) when compared to feeding on leaf grown by application of muriate of potash to other varities (Table 16) (Nagaraju and Shankar, 1997).

The results clearly indicate that the silkworm larval weight increase with the external supply of nitrogen and potassium sulphate when compared to potassium chloride application to mulberry. This may be due to feeding of silkworms with fresh leaves containing more chlorophyl content which in turn increase the total soluble protein content in the mulberry leaf. In line with the present study Sidhu *et.al.* (1969) reported that silkworms reared on leaves fertilized with K, the weight of full grown larva was more. Radha *et al.* (1988) reported a decrease in larval weight when worms was fed with K deficient leaves. Yakoyama (1954) indicated that the fifth instar larva having sufficiently grown silk glands for secreting silk and spinning cocoons require protein rich mulberry leaf. Thus, this improved leaf quality may have aided in sturdier development of silkworm.

COCOON WEIGHT

The cocoon weight was influenced by the graded levels of potassium sources along with graded levels of nitrogen application.

The weight of cocoons spun by worms fed on leaf obtained by application of 180 kg/ha/yr potassium as sulphate of potash in five splits recorded significantly higher single cocoon weight (1.76g) when compared with other lower levels of potassium application including same level of potassium application as muriate of potash (1.63g) and normal recommended package 120 kg/ha/yr K application in two splits (1.65) (Table 12) (Shankar, 1997).

The cocoons spun by silkworm fed on mulberry leaf grown by application of 300:200 kg/ha/yr nitrogen and potassium recorded higher cocoon weight of all three popular breeds of silkworms (1.07 in PM, 2.01 NB_4D_2 and 1.51 in cross breed silk worms) when compared to cocoons spun by worms fed on leaf obtained by control plots (0.94, 1.71 and 1.2 g in PM, NB_4D_2 and cross breed silk worms respectively) (Table 13).

Table 14 : Silkworm growth and cocoon parameters of PM and NB_4D_2 silkworm breeds as influenced by feeding of mulberry leaf obtained by application of N and SOP in different levels

Treatments	Mature worm Wt.(g)		Cocoon Wt.(g)		Shell Wt.(g)		No. of Cocoons/kg		B:C Ratio	
kg/hg/yr	PM	BV	PM	BV	PM	BV	PM	BV	PM	BV
200:120:160 K_2SO_4	14.5	27.4	0.80	1.50	0.10	0.27	1200	841	1.4	4.6
250:120:180 K_2SO_4	14.8	28.9	0.80	1.87	0.10	0.28	1259	839	1.4	3.2
300:120:120 KCl	15.6	30.3	0.97	1.59	0.11	0.29	1030	764	2.0	3.9
300:120:120 K_2SO_4	15.4	30.7	1.04	1.71	0.11	0.34	969	720	2.3	4.8
350:120:160 K_2SO_4	16.6	37.0	1.00	1.92	0.13	0.36	949	698	2.4	4.5
400:120:180 K_2SO_4	17.1	38.21	1.11	2.01	0.14	0.37	930	647	2.6	3.5
F test	*	*	*	*	*	*	*	*		
C.D. at 5%	0.02	0.47	0.05	0.03	0.01	0.01	53.7	26.5		

A study on pure breeds of worms confirmed the fact that heavier weight of cocoons (1.11 and 2.01g in PM and NB_4D_2) breeds was noticed wherein cocoons spun by the worms fed on mulberry grown by application of higher rates of nitrogen and sulphate of potash (*i.e.* 400: 180 kg/ha/yr (Table 14) (Rajegowda and Shankar, 2000).

In farmers field study on pure breeds of silkworms revealed that the cocoons spun by worms fed on leaf raised by application 400:180 kg/ha/yr nitrogen recorded higher single cocoon weight (1.07g in PM and 1.86g in NB_4D_2 breeds) (Table 15) (Rajegowda and Shankar, 2000).

Table 15 : Silkworm growth and cocoon parameters of PM and NB_4D_2 silkworm breeds as influenced by feeding on leaf raised by application of different levels of N and K_2SO_4 at farmer's field

Treatments kg/hg/yr	Mature worm Wt.(g)		Cocoon Wt.(g)		Shell Wt.(g)		No. of cocoons/kg	
	PM	BV	PM	BV	PM	BV	PM	BV
T1 300:120:120 KCl	1.56	2.90	0.85	1.56	0.10	0.29	1180	842
T2 350:120:160 K_2SO_4	1.77	3.77	1.07	1.63	0.11	0.30	959	748
T3 400:120:180 K_2SO_4	1.87	4.13	1.07	1.86	0.15	0.37	943	714
T4 300:120:120 K_2SO_4	1.67	3.33	0.99	1.66	0.13	0.31	1006	718
F test	*	*	*	*	*	*	*	*
C.D. at 5%	0.07	0.15	0.03	0.06	0.01	0.01	75.1	50.2

SHELL WEIGHT

The cocoon spun by the worms fed on mulberry leaf grown by application of 180 kg/ha/yr showed higher shell weight (0.300g) followed by 160 kg/ha/yr (0.288g) when compared to growing mulberry on normal practice *i.e.* application of 120 kg/ha/yr (as KCl) (0.23g) (Table 12) (Shankar, 1997).

The study conducted by Rajegowda and Shankar (2000) on feeding of different breeds of silkworm feeding on mulberry leaf, silkworms grown by application of higher rates of nitrogen and potassium (as SOP) at 300:200 kg/ha/yr recorded higher shell weight (0.14g in PM, 0.3 g in BV and 0.24 g in CB) as compared to rearing of silkworms on mulberry leaf grown by normal practice (0 .13g in PM, 0.31g in BV and 0.20g in CB) (Table 13). In another experiment on pure breeds of silkworms showed increase in shell weight with feeding of PM and NB_4D_2 breeds on leaf grown by application of N and K (as K_2SO_4) at 400:180: kg/ha./yr (0.14g in PM and 0.37g in NB_4D_2) In control it was 0.11 g in PM and 0.29g in NB_4D_2 (Table 14).

Farmers field trial confirmed the fact that feeding of worms on mulberry leaf grown by higher rates of nitrogen and potassium in the form of sulphate of potash at 400:180 kg/ha/yr showed higher shell weight (0.15g in PM and 0.37g in NB_4D_2 breeds) when compared to feeding of worms on leaf grown on normal practice with 300:120 kg/ha/yr N and K (as MOP) (0.10g in PM and 0.29g in NB_4D_2 breeds) (Table 15).

FILAMENT LENGTH

The increase in single cocoon filament length was noticed due to feeding of worms on leaf grown by application of higher rates of nitrogen and potassium sulphate. The filament length was significantly higher in the cocoons spun by worms fed on mulberry leaf grown by application of potassium (as SOP) at 180kg/ha/yr (817 m) and 160 kg/ha/yr in five splits when compared to feeding on control plots (777m) (Table 12) (Shankar, 1997)

Study on feeding different breeds of silkworms on leaf grown by application of varied rates of N and K (as SOP) revealed that application of 300:200 kg/ha/yr showed higher filament length (359m in PM,968 m in NB_4D_2 and 780m in CB) (Table 13) (Shankar and Rajegowda, 2000). Further in another experiment on different variety RFS-175 with application of sulphate of potash showed higher filament length (834m) (Table 16) (Nagaraju,1997)

NUMBER OF COCOONS PER KILOGRAM

Number of cocoons per litre were lesser when cocoons were spun by worms fed on mulberry leaf grown by supply of 300:200 kg/ha/yr N and K (as K_2SO_4) (937 in PM, and 625 in NB_4D_2 breeds) (Table 13). Further, the lesser number of cocoons per kg was noticed when worms were reared on leaf grown by application of 400:180 kg/ha/yr nitrogen and potassium (as SOP) (930 in PM and 647 in NB_4D_2 breeds)(Table 14). In farmer's field experiment the lesser number of cocoons per kilogram were noticed when nitrogen and potassium as sulphate of potash was applied at higher rates *i.e.* 400:180: kg/ha/yr (943 in PM and 714 in NB_4D_2) when compared to other lower levels of nitrogen and potassium sulphate application including control (Table 15)

FILAMENT DENIER

The higher filament denier was noticed when higher rates of nitrogen and potassium (as sulphate of potash) was applied to mulberry.

Table 16 : Silkworm growth, cocoon and post cocoon parameters as influenced by feeding on leaves obtained from different mulberry varieties grown under different potassium sources in rainfed condition

Treatment	Mature worm Wt(g)	Cocoon Wt. (g)	Shell Wt. (g)	No. of cocons/Kg. (No.)	No. of breaks in filament (No.)
V1K1	3.20	1.72	0.284	751	10.05
V1K2	3.23	1.75	0.296	782	7.16
V2K1	3.29	1.77	0.308	805	6.49
V2K2	3.30	1.81	0.318	811	3.72
V3K1	3.25	1.83	0.328	812	3.66
V3K2	3.33	1.86	0.336	834	1.49
V4K1	3.12	1.67	0.267	713	12.55
V4K2	3.18	1.73	0.281	742	9.83
F test	NS	NS	NS	NS	NS

V1= MR_2 V2=S_{34} V3=RFS-$_{175}$ V4=M_5 K1=KCl K2=K_2SO_4

The cocoon weight, shell weight and silk filament length was increased by feeding of worms on leaf grown by supply with increased nitrogen and potassium through SOP may be due to improvement in nitrogen content of leaves along with soluble protein and sugars. The mulberry leaf proteins are the source for silkworms to biosynthasize silk which is made up of two proteins namely fibroin and sericin. The increase in nitrogen levels increased the protein content which in turn increase silk content in silk glands and ultimately cocoon yield. These results are in confirmity with the findings of Sengupta *et al.* (1972) and Das *et al.* (1993).

Indeed, these findings reveal the importance of nutrient status in the leaf for the silkworm growth, development and subsequently to improvement in the cocoon parameters which is a step in right direction to achieve the quality and to harvest higher cocoons yield, which in turn maximise the profitability of Sericulture.

III GRAINAGE PARAMETERS

RATE OF MOTH EMERGENCE

Moth emergence rate noticed marked difference when pure races of silkworms *viz.* Pure Mysore and NB_4D_2 breeds of silkworms, reared on mulberry leaf grown by application of different levels of nitrogen and potassium (as SOP)

Table 17 : Grainage parameters of PM, NB_4D_2 and PM x NB_4D_2 breeds as influenced by feeding of silkworms on mulberry leaf obtained by application of N and K_2SO_4 at different levels

Treatment kg/hg/yr	Rate of month emergence (%) PM	BV	Fecundity (Nos) PM	BV	CB	Unfertilized egg (%) PM	BV	CB	Dead egg (%) PM	BV	CB	Hatching percentage PM	BV	CB
T1 180:120:160 K_2SO_4	73.3	59.8	395	476	373	2.5	1.7	2.1	3.7	2.5	2.4	84	68	87
T2 240:120:180 K_2SO_4	73.3	60.3	430	505	420	2.7	1.7	1.7	3.3	2.5	1.6	89	74	90
T3 300:120:200 K_2SO_4	83.1	70.0	466	605	499	1.6	0.6	0.5	1.7	0.6	0.5	94	91	94
T4 300:120:120 K_2SO_4	76.9	62.5	425	549	470	2.5	1.7	1.4	2.9	2.6	1.4	92	90	93
T5 300:120:120 KCl	80.8	64.6	451	527	452	1.9	1.1	1.7	1.7	2.1	2.4	93	89	89
F test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
C. D. at 5%	0.02	5.60	38.9	42.0	14.8	2.25	2.39	1.87	0.21	0.07	1.7	0.64	1.51	2.59

The moth emergence rate was significantly higher when silkworms were reared on leaf grown by application of higher rates of nitrogen (300 kg/ha/yr) along with potassium (180 kg/ha/yr) as sulphate of potash (83.1 % in PM and 70.0% in NB_4D_2) when compared to application of lower levels of nitrogen and potassium (Table 17). Further, in another experiment the rate of moth emergence was higher when silkworms were reared on leaf raised by 400:180 kg/ha/yr N and K (as SOP) application (87.67% in PM, 76.75% in NB_4D_2 breeds). In control plots the rate of moth emergence was 83.33 per cent in PM and 70.5 per cent in NB_4D_2 (Table 18).

FECUNDITY

The fecundity in different breeds of silkworms noticed significant difference due to feeding of worms on leaf grown by application of different levels of nitrogen along with two potassium sources.

The fecundity was significantly higher in the eggs laid by the moths obtained by rearing on mulberry leaf grown by application of nitrogen and potassium (as SOP) at 300:.200 kg/ha/yr (466 in PM, 605 in NB_4D_2 and 490 in CB) (Table 17). Further, the higher fecundity in another experiment was noticed when mulberry was grown by application of 400:180 kg/ha/yr N and K (as SOP) and same leaf fed to silkworms and the moths obtained from this treatment recorded higher fecundity PM 436 NB_4D_2 636 and CB 484 (Table 18).

In farmer's field study, the fecundity was higher when silkworms were reared on mulberry leaf grown by application of N and K_2SO_4 at 400:180 kg/ha/yr (399 in PM and 504 in NB_4D_2) and the cocoons spun by these worms subjected to moth emergence. In the normal practice followed control plot the fecundity was 348 in PM and 413 in NB_4D_2 (Table 18).

Table 18 : Grainage parameters of PM, NB_4D_2 and PM x NB_4D_2 breeds of silkworms as influenced by feeding of M_5 mulberry leaf obtained by application of N and K_2SO_4 at different levels

Treatment kg/hg/yr	Rate of month emergence (%)		Fecundity (Nos)			Hatching percentage		
	PM	NB_4D_2	PM	NB_4D_2	PM x NB_4D_2	PM	NB_4D_2	PM x NB_4D_2
T1 100:120:160 K_2SO_4	73.3	63.63	334	486	404	81	75	91
T2 250:120:180 K_2SO_4	74.42	60.10	356	478	431	90	79	91
T3 300:120:120 KCl	83.33	70.50	409	520	421	92	87	92
T4 300:120:120 K_2SO_4	84.99	70.49	447	582	442	93	88	93
T5 350:120:160 K_2SO_4	87.17	75.75	432	631	466	93	91	92
T6 400:120:180 K_2SO_4	87.67	76.75	436	636	484	94	91	93
F test	*	*	*	*	*	*	*	*
C. D. at 5%	8.74	2.72	2.24	40.12	11.82	2.40	1.00	2.43

The increase in fecundity and hatching percentage is may be due to feeding of worms on nutrients rich leaves (macro and micro nutrients) along with higher soluble sugars and protiens. In addition, due to increased nutrient status of leaf, the moth were able to encapsulate higher portion of sulphur which has relevence to state the outer cover of the silkworm eggs shell called as Corian layer which contain sulphur which is the first food for silkworm ants (newly hatched worm) which has proved beyond doubt, it would help in development of disease resistance capacity to grownup worm if the young worms had fed on sulphur rich Corian layer, immediately after hatching.

Indeed, like in any other industry the silkworm eggs production is also basic input in Sericulture which contribute to the tune of 15 to 20 per cent for successful completion of economic rearing. The present findings have proved beyond doubt that the supplying S through SOP along with higher levels of N is highly beneficial in improving the post cocoon parameters, specially the grainage parameters, nevertheless, by extending this technology in the seed areas, the Sericulture progress and development will be on sustainable scale.

DISEASE INCIDENCE

The disease incidence was lesser when mulberry grown by application of higher quantity of potassium (as SOP) when compared to lower levels of potassium application.

HIGHLIGHTS

* The Mulberry leaf yield increased to the extent of noteworthy (8 to 32%) when mulberry was grown by application of higher rates of nitrogen and potassium in the form of SOP.

* The increased rates of nutrient application specially SOP in balanced proportion improves the nutritional status and bio-chemical parameters of leaf.

* Feeding of silkworms with mulberry leaves grown by application of higher quantity of sulphate of potash along with nitrogen improves the silkworm growth, cocoon production and post cocoon parameters.

* The grainage parameters *viz.* rate of moth emergence, fecundity, hatching percentage and egg weight improved with the feeding on leaf grown by application of higher rates of potassium sulphate along with nitrogen and the moths obtained from these improves the grainage. parameters.

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